PRODUCTION ENGINEERING LABORATORY — SECTION 3

Downhole Drilling Equipment and Tools

Restoration, Function, and Field Reference

Restored tools — Production Engineering Laboratory, DUIET

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1. Introduction

This document covers the downhole drilling tools restored as part of the Production Engineering Laboratory development exercise — the drill bit and the connecting hardware that makes up the lower part of the drill string. Each entry includes function, working principle, a schematic, and QR-linked video/reference material.

2. Tricone (Roller Cone) Drill Bit

The tricone bit is a rotary drill bit fitted with three independently rotating cones, each studded with either milled steel teeth or tungsten carbide inserts (TCI).

2.1 Working Principle

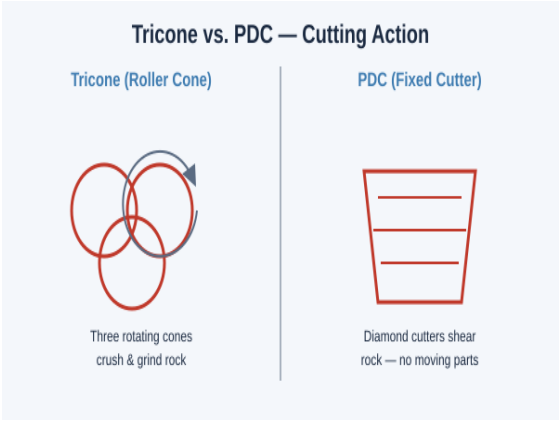
As the bit rotates and weight is applied (weight on bit), each cone spins on its own bearing axis and rolls along the bottom of the hole. The teeth or inserts on the cones crush, chip, and grind the rock through a combination of compressive and grinding action rather than a continuous shearing cut.

2.2 Formation Suitability

- Steel-tooth (milled tooth) cones: longer, more widely spaced teeth, suited to softer formations.
- Tungsten carbide insert (TCI) cones: harder, more wear-resistant inserts, suited to medium-to-hard and abrasive formations.
- Because the cones ride on lubricated, sealed bearings, tricone bits remain effective and durable across a wide range of formation types, including where formation hardness varies with depth.

2.3 Restored Tool — Photograph & Schematic

Tricone (Roller Cone) Drill Bit, restored



Tricone vs. PDC cutting action (schematic)

2.4 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

[Video: Tricone drill bit working animation — search (YouTube)]

[Reference: PDC Drill Bit vs Tricone — Differences (SinoDrills)]

3. PDC (Polycrystalline Diamond Compact) Bit

A PDC bit is a fixed-cutter bit with no moving parts. Synthetic polycrystalline diamond cutters are bonded to a tungsten-carbide substrate and mounted on blades around the bit face.

3.1 Working Principle

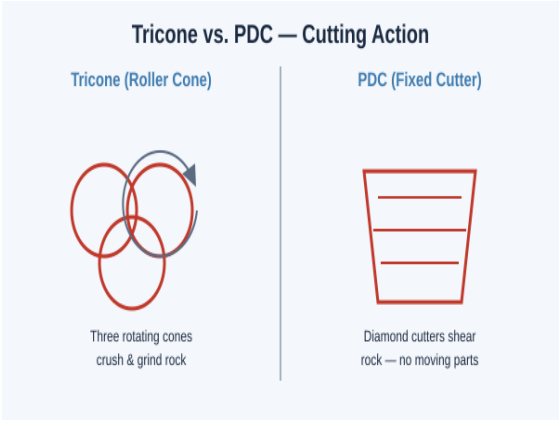
As the bit rotates, the diamond cutters continuously shear thin layers off the rock face, similar to the action of a lathe tool, rather than crushing the rock as a tricone bit does. This continuous shearing produces less vibration and, in suitable formations, a notably higher rate of penetration than a comparable tricone bit.

3.2 Advantages and Trade-offs

- No bearings or moving cones to wear out or fail downhole, which removes a common tricone failure mode (lost cone/cutting structure in the hole).
- Excels in soft-to-medium, relatively homogeneous formations such as shale, sandstone, and limestone.
- Tricone bits generally retain an advantage in highly abrasive, fractured, or widely varying hard formations.

3.3 Restored Tool — Photograph & Schematic

PDC (Polycrystalline Diamond Compact) Bit, restored



Tricone vs. PDC cutting action (schematic)

3.4 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: PDC drill bit working animation — search (YouTube)

Reference: Tricone Drill Bit vs PDC Bit (SML Tools)

4. Bit Sub and Cross-Over Sub (X-Over)

4.1 Bit Sub

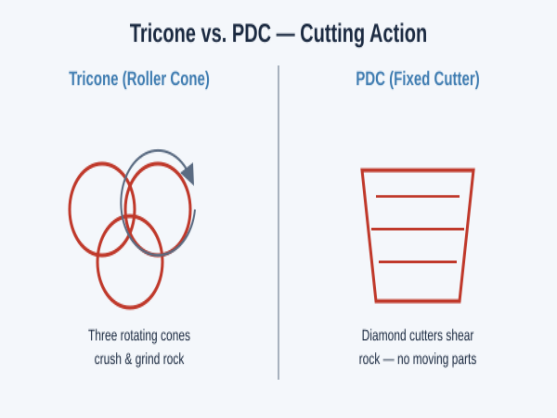
A bit sub is a short connecting sub placed between the drill bit and the bottom-hole assembly (BHA) above it. It adapts thread types or connection sizes between the bit and the BHA, and in some designs also houses a float valve to prevent backflow of fluid up the drill string.

4.2 Cross-Over Sub (X-Over)

A cross-over sub connects two drill string components that use different thread types or sizes — for example, joining a different connection standard between the drill pipe and a downhole tool. This allows mixed equipment from different manufacturers or specification standards to be safely run together in a single string.

4.3 Restored Tools — Photograph & Schematic

Bit subs, cross-over subs, and drill collar/pipe sections, restored


Tricone vs. PDC — Cutting Action
Tricone (Roller Cone)
PDC (Fixed Cutter)
Three rotating cones crush & grind rock
Diamond cutters shear rock — no moving parts

Bit-to-BHA connection concept

4.4 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Bit sub / cross-over sub — search (YouTube)

Reference: Tricone Bit — an overview (ScienceDirect Topics)

5. Drill Pipe and Pipe Joint Classification & Identification

Drill pipe is the tubular that makes up the bulk of the drill string length, connecting the surface equipment to the bottom-hole assembly and bit. It both transmits rotational torque from the rig and conveys drilling fluid down to the bit.

5.1 Classification Parameters

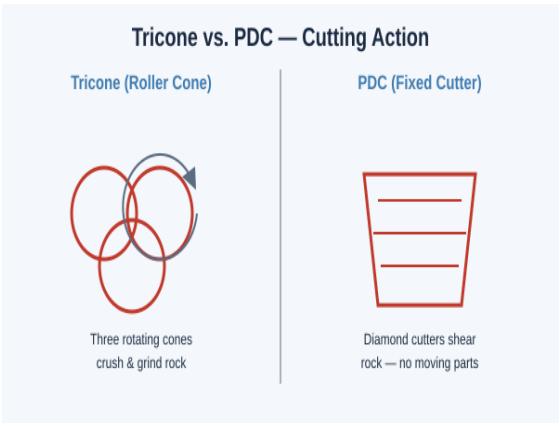
- Range length — the standard joint-length category (e.g., Range 2 is the most common in API practice).
- Nominal weight — weight per unit length, affecting strength and pressure rating.
- Steel grade — governs the pipe's yield strength and torsional capacity.
- Connection type — the tool joint thread form, which must match across the string.

5.2 Visual Identification

Colour bands and stencilled markings on the tool joint allow crews to identify grade and class at a glance on the rig floor, without needing to measure or consult paperwork for every joint — an important practical efficiency during tripping operations.

5.3 Restored Tools — Photograph & Schematic

Overshot tool



Bit and BHA cutting-structure reference

5.4 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Drill pipe classification, range, grade — search (YouTube)

Reference: IADC — International Association of Drilling Contractors

6. Summary Table

Tool	Primary Function	Best Suited For
Tricone Bit	Crushes/grinds rock via 3 rotating cones	Variable / hard, abrasive formations
PDC Bit	Shears rock via fixed diamond cutters	Soft–medium homogeneous formations
Bit Sub	Connects bit to BHA, adapts threads	Bit-to-BHA interface
Cross-Over Sub	Joins mismatched thread types/sizes	Mixed equipment strings
Drill Pipe	Transmits torque, conveys fluid to bit	Length of the drill string

This concludes Section 3 of the Production Engineering Laboratory tool reference series.